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SOME PARTICULARITIES OF DEVELOPMENT OF THE EUROPEAN ALPIDES AND WEST CARPATHIANS, MAINLY FROM THE VIEWPOINT OF NEW GLOBAL TECTONIC

(Fig. 1—9)

A b s t r a c t: Revaluation of the meaning of tectonogroups (= tectofacies groups), characteristic of the individual tectonic units of the Carpathians, Balkans and Dinarides, used in the Tectonic Map of the Carpathian-Balkan regions 1 : 1,000.000 (M. M a h e ľ 1973) and analysis of the geotectonic position of magmatites in these segments of the European Alpides (M. M a h eľ — in press) permit the author to take up an attitude to a series of questions, more often discussed from the global viewpoint. They are:

1. Differentiation of the Alpine geosynclinal system during the Early Paleozoic;

2. The role of Hercynian granitization in formation of structures and the influence of unequal stabilization on further development of the geosynclinal system;

3. Several types of Triassic tectonogroups and manifestation of magmatism as indicator of crust differentiation already in the Triassic;

4. Great structural-facial dissection in the Jurassic and Lower Cretaceous; with troughs of regional extension — connections of several segments of the geosynclinal system;

5. Several types of crust shortening during the Alpine folding, subduction zone-extreme type of shortening;

6. Particularities in the individual segments in the variety of flysch types; its linking of ophiolite zones with the preflysch;

7. Unequability and several type of late-geosynclinal volcanics; their genetic relations to subduction zones but also to central massifs.

Р е з ю м е: Переоценка значения тектоногрупп (= групп тектофаций) характерных для отдельных тектонических единиц Карпат, Балкана и Дина ид, примененных в Тектонической карте Карпато-балканских регионов в масштабе 1 : 1 000 000 (М. М а г е л ь 1973) и анализ геотектонической позиции магматитов в данных сегментах европейских альпид (М. М а г е л ь — в печати) позволяют автору высказаться к ряду вопросов более часто обсуждаемых с глобальной точки зрения. Такими являются:

1. Дифференциация альпийской геосинклинальной системы во время более древнего палеозоя;

2. Роль герцинской гранитизации в формировании структур и влияние неравномерности стабилизации на дальнейшее развитие геосинклинальной системы;

3. Многотипность тектоногрупп триаса и проявления магматизма в качестве показателя дифференциации коры уже во время триаса;

4. Большая структурно-фациальная расчлененность во время юры и нижнего мела; с трогами большего регионального простирания — соединениями нескольких сегментов геосинклинальной системы;

5. Многотипность сокращения коры во время альпийской складчатости· зоны субдукции, крайный тип сокращения;

6. Основание зон офиолитов на префлише со своеобразиями в отдельных сегментах;

7. Неравномерность и в то же время многотипность позднегеосинклинальных вулканитов; их генетическая связь с зонами и субдукций, но также и к центральным массивам.

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Certain homogeneity of the Alpide system is conditioned by equal development trend with some common features of development and structure of the European Alpides, also by the existence of tectonic units, through which several, mainly adjacent segments of the Alpine system are linked. Each segment, however, has a whole series of structural particularities, some units, as a consequence of particularities of development. Judgement of these particularities, mainly on the example of the West Carpathians, in the frame of more general regularities of development and structure of the Alpine system, makes possible to take up a standpoint in many questions, more often discussed from the position of new global tectonics in the last years.

1. Facial variety of the pre-Carboniferous groups in the Alpides is essentially lesser than of the Mesozoic groups. Concerned is mainly a lesser variety of groups, mainly carbonate ones, proportion of which, e. g. in the West Carpathians, is minimum. On the contrary, in Early Paleozoic and older groups are many volcanogenic complexes. The unequal distribution of the Spilite-diabase and Spilite-keratophyre group in the individual zones, however, testifies to dissection of the Early Hercynian geosynclines with throughs with a thinned out to oceanic crust. The basaltoid groups are accompanied by gabbros and serpentinites. Such one in the West Carpathians are the Hron group in the North Veporides, the Phyllite-diabase group in the northern part of the Gemerides and the Pezinok-Pernek group in the Tatrides (Malé Karpaty). In the Balkans the Diabase-Phyllitoid group is known, in the East Carpathians the Repedea group, in the Apuseni the Paiuseni group, etc.

Some Early Paleozoic groups display richer representation of quartz porphyries, particularly abundant in the Ordovician (the Gelnica group in the Gemerides of the West Carpathians, Blaseneck-porphyries in the Grauwackenzone of the Eastern Alps, Tulges group in the East Carpathians). Concerned are there groups of geosynclinal character with lateral and vertical transition into spilite--diabase groups, however, genetically linked perhaps with ridges and/or island zones. Thus obviously already the Baikalian, partly the Late Baikalian (and Caledonian) folding was distinctly manifested in differentation of crust with zones of oceanic to thinned out crust and zones of thicker crust. The fundamental character of the type of formations, however, changed in the Alpides by the extensive Hercynian granitization only (Fig. 1).

2. Characteristic of the Hercynian folding is linking with extensive granitization of the wide time diapason (up to 120 m. y.), the distinct structure-forming and morphostructural influence-conditioned by the abundance of batholiths and fakkoliths, their diapiric ascent, reworking and consolidation of crust, change of the type of geosynclinal regime. The accompaniment of the Hercynian folding by granitization and metamorphism is an evidence of deep-character folding.

The Hercynian folding is the first one in the Alpides with a distinct structural plan, partly directed by uplift of granitoid masses. The Late Hercynian molasses, appearing for the first time in development of the Alpides, are filling up grabens, usually accompanying the marginal parts of zones with granitoid masses; they are prevailingly of linear character. Only to a lesser degree in marginal areas also depressions of transversal orientation originated (Tatride zone in the West Carpathians). The quartz porphyries wich accompany the molasse filling of the grabens are a surficial manifestation of the Hercynian granitization.

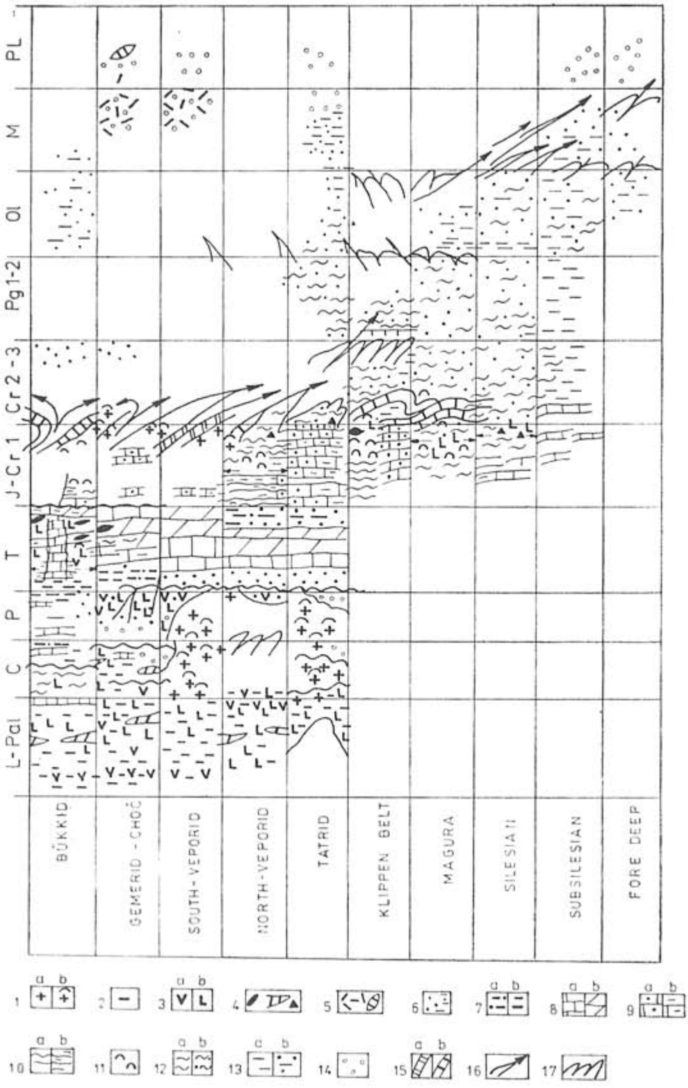

Fig. 1a. Figure showing geotectonic evolution of the West Carpathians.
1 — Granitoid penetrations a) diapiric ascendances; 2 — Aspidic flyschoid and flysch Prealpine formations; 3 — Quartz porphyries a) spilite-diabases, melaphyres; 4 — Ultrabasic bodies a) of basic intrusives, b) of alcalic basic and ultrabasic; 5 — Andesites and rhyolites a) basalts; 6 — Sandstones, quartzites a) Carpathian Keuper; 7 — Shallow-marine detrital sediments a) with predominanting pelites" 8 — Shelf limestones a) dolomites; 9 — Carbonates of intrageosynclinal a) ridges, b) basins, troughs; 10 — Trough facies, predominantly marls; a) pelagic limestones; 11 — Thick radiolarites; 12 — Flysch a) coarse flysch; 13 — Shelf and trough sedimentes with predominantly pelites a) sandstones; 14 — Molasses; 15 — Occurrences of high-temperature and high-pressure metamorphism a) subduction zones; of high pressure and low-temperature metamorphism; 16 — Overthrust" 17 — Upthrusts; folds.

Stressed should be, however, the unequality of the Hercynian consolidation in the individual segments in the Alpides, also in the individual zones of the same segment. The West Carpathians are a clear example of it, with zones of distinct Hercynian granitization (Tatrides, South Veporides), zones of intense Hercynian folding but without more extensive granitization (North Veporides) and with zones of lesser Hercynian folding and insignificant Hercynian granitization (Gemerides and mainly Bükkides) Fig. 2, 3.

3. As a consequence of the Hercynian stabilization quite generally in the Alpides is considered the quasi-platform type of the Triassic with predominating shallow-water limestone or dolomite facies and lagoonal and terrestrial facies of Keuper type. Such one is only the Unterostalpin Triassic, the Triassic of the more northern units of the West Carpathians – the Carpathian Triassic and Balkanide Triassic.

In the Austroalpine Triassic (building up the Northern Calcareous Alps and Drava Zone, also the more southern nappes of the West Carpathians and Apuseni) a distinct structural-facial dissection with zones of channel type facies (Reifling limestones, Zlambach shales, Hallstatt limestones) even with flysch--Lunz beds is characteristic.

In the southernmost zones of the Carpathians, Meliata, Bükk, in the Southern Alps and Dinarides a type of the Triassic with volcanics of porphyrite and of basaltoid type is abundant, also with considerable proportion of pelagic limestones, also pelites, silicites and with flysch. As the Austro-alpine Triassic we may range the type of dissected swell or ridge or dissected shelf, the latter type with basaltoids being more of trough character.

It cannot be considered as accidental that the zones with a more deep-water type of the Triassic have a Permian with predominating marine facies (Budva--Zukali, Drina, Vardar, Bükk-Meliata).

Unegualness of Hercynian stabilization obviously played a distinct role not only in the differences of the Hercynian structural plan but also in development of the Alpine geosyncline.

To the above mentioned three types of the Triassic (Fig. 4) we still join the types with thick flysch and deep-water carbonate facies as the Triassic in the Kotel Zone in the Balkans and Northern Dobrudja – obviously the western promontories of the Tauric trough of the Caucasus.

4. The period of the Jurassic and Lower Cretaceous is indubitably that of greatest structural-facial dissection of the Alpides with abundant sequences of trough type (pelitic carbonates, marlstones, radiolarites), separated by ridges and accompanied by sequences of marginal basins. It should be stressed, however, the variety of paleotectonic types, of the troughs, thus also of these with basic and ultrabasic rocks. In the West Carpathians we distinguish even four troughs in the Jurassic and Lower Cretaceous period, each with sequences characteristic of it (Fig. 7); a) the Meliata trough in the south (linked with the Triassic trough); b) more northerly the Krížna trough – in the North Veporides; c) in the Klippen Belt the Kysuca-Pieninic trough with subduction; d) the most extensive and possibly also with most distinct oceanization of crust the trough represented by the lower stage of the Magura (and partly perhaps also of the Silesian nappe) of the Carpathian Flysch Belt. Some of the troughs are obviously running through several segments of the Alpides as the mentioned Penninic – Magura – Ceahlau – Severin troughs, obviously represent some

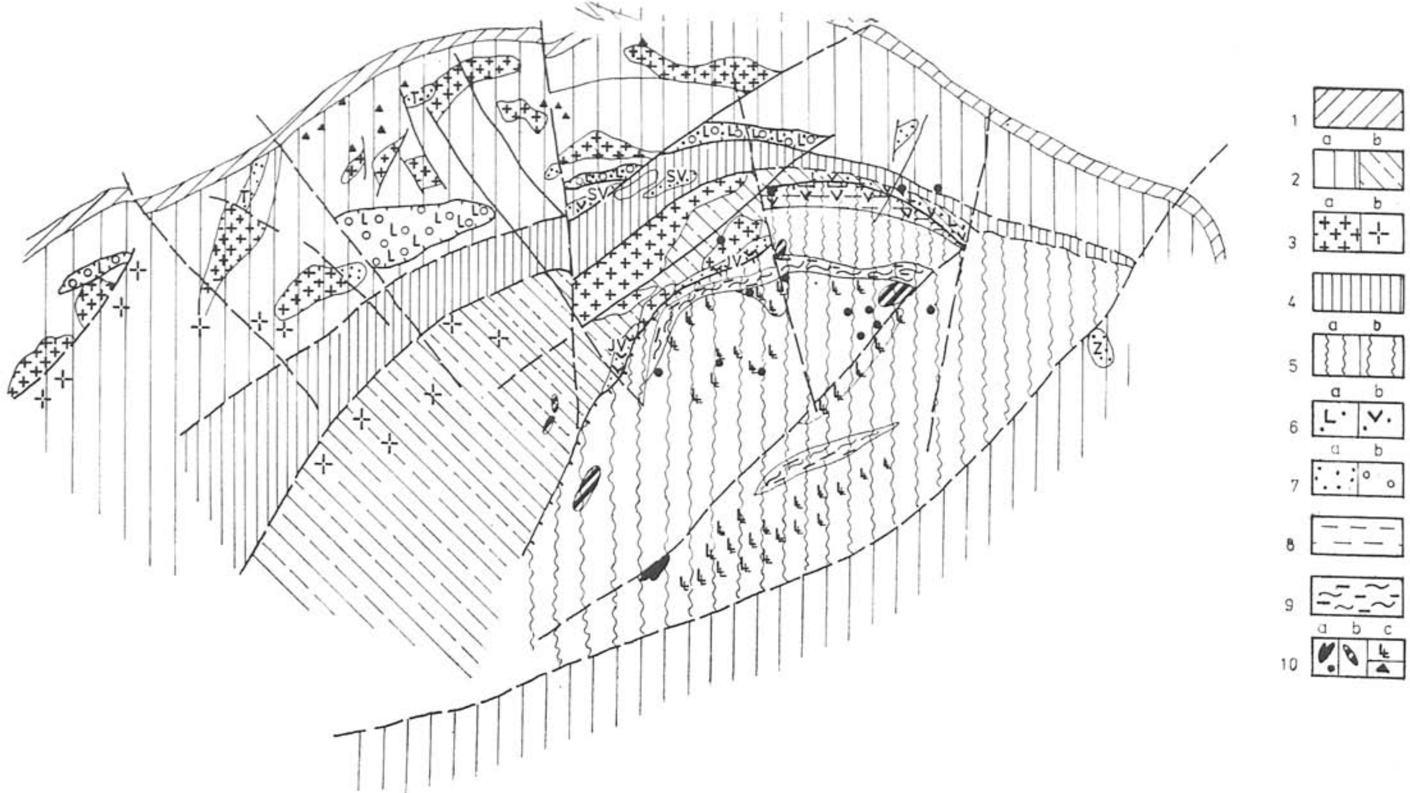

Fig. 2. Zones of different Hercynian stabilization and the distribution of Permian types in the West Carpathians. 1 — Klippen Belt; 2 — Zones of intensive granitization and intensive Hercynian folding a) predominantly autochthonous (Tatrides, Hungarian mass.), b) most commonly paraautochthonous-allochthonous (South Veporides); 3 — Granitoid massifs: a) on the surface, b) in the basement of Neogene mantle; 4 — Zones of intensive Hercynian folding but without large-scale granitization (North Veporides); 5 — Zones of minor Hercynian stabilization a) with a small portion of Hercynian granitoids, b) very slightly folded and lacking granitoids; 6 — Permian: a) melaphyres (in nappe position), b) quartz porphyries; 7 — a) Permian of terrestrial type T = Tatride, SV = North Veporide, JV = South Veporide; Z = Zemplín; b) Permian of the Choč nappe; 8 — North Gemeride Permian; 9 — Permian, partly marine; 10 — Ophiolites — Basaltoides; a) Ultrabasites, b) Intrusive basites, c) Diabases, d) Quartz-porphyries-keratophyres-diabasee.

tinct structural-facial dissection of the geosyncline in the Jurassic and Lower connecting links in development of the Alpine system. The other troughs are of more restricted extent, characteristic of the individual segments, e. g. the Krížna trough of the West Carpathians.

The presence of basaltoids and ultrabasic rocks, predominantly in trough facies, justifies the opinion that there are zones with thinned out or torn up continental crust (Fig. 5).

In paleotectonic considerations, besides thickness of crust, however, the dis-

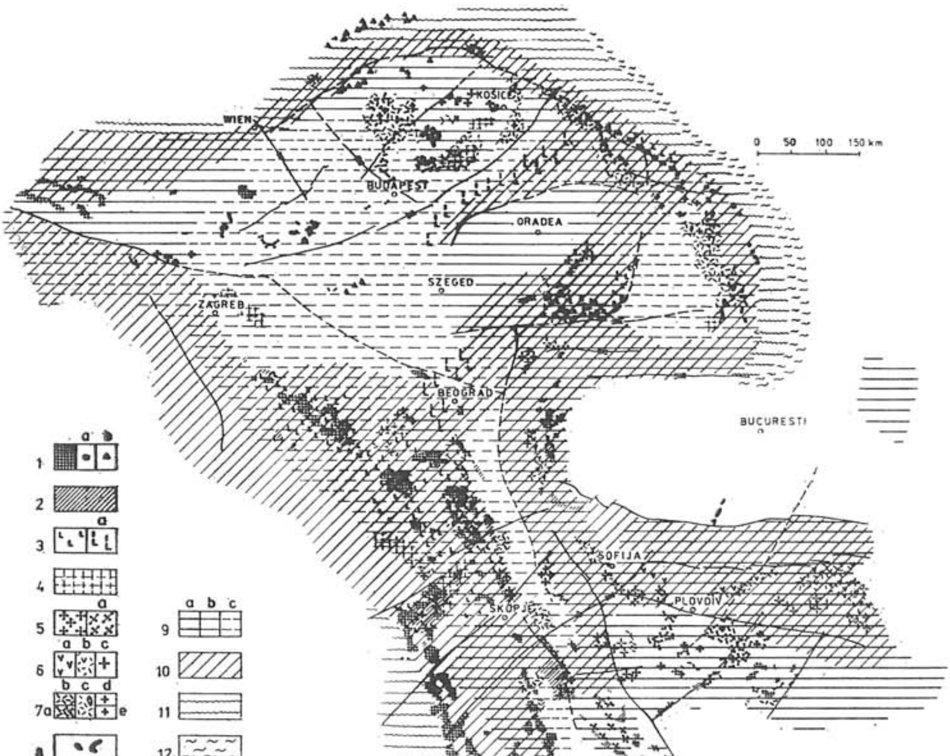

Fig. 3. Sketch-map of relation of manifestation of Alpine folding periods to magmatites in the Carpathian-Balkan system. Magmatites: 1 — Ultrabasites a) Minor bodies in allochthonous position, b) alkalic ultrabasites; 2 — Intrusive basites (mainly gabbros); 3 — Spilites and diabases (Jurassic-Lower-Cretaceous), a) in the underlier of the Tertiary basin filling, alkalic; 4 — Triassic diabases, porphyrites, quartz porphyrites, keratophyres; 5 — Paleoalpine granites a) synkinematic; 6 — Banatites a) major effusive bodies, b) major pyroclastics, c) subvolcanic and plutonic bodies; 7 — Neovolcanics: a) early late-geosynclinal (Priabone-Oligocene, b) late-geosynclinal (Miocene--Pliocene), c) pyroclastics, d) minor intrusive bodies (Miocene), e) minor intrusive bodies (Priabone-Oligocene); 8 — "Basalts" Regions: 9 — a) More distinctly affected by Kimmerian (mainly Neokimmerian) folding, b) Paleoalpine-folded (in the Austrian to Subhercynian phase), c) Only slightly affected by Paleoalpine folding; 10 — Mesoalpine-folded (in the Laramide to Pyreneic phase); 11 — Neoalpine-folded (in the Savian to Styrian phase); 12 — Late-Neoalpine (to the end of the Neogene and in the Quaternary), affected by folding.

Cretaceous and many-type tectofacies or tectonogroup complexes should not be neglected. In the Tectonic Map of Carpathian-Balkan Regions 1 : 1,000.000 we distinguished up to 20 different types of tectonogroups of the Jurassic-Lower Cretaceous period. The cause of this dissection but also fracturing of crust is also that augitites and limburgites are often found also in ridge-type sequences (e. g. in the Tatride unit of the High Tatra). More often they occur at the boundary between troughs and cordilleras (e. g. alkalic teschenites in the Silesian nappe).

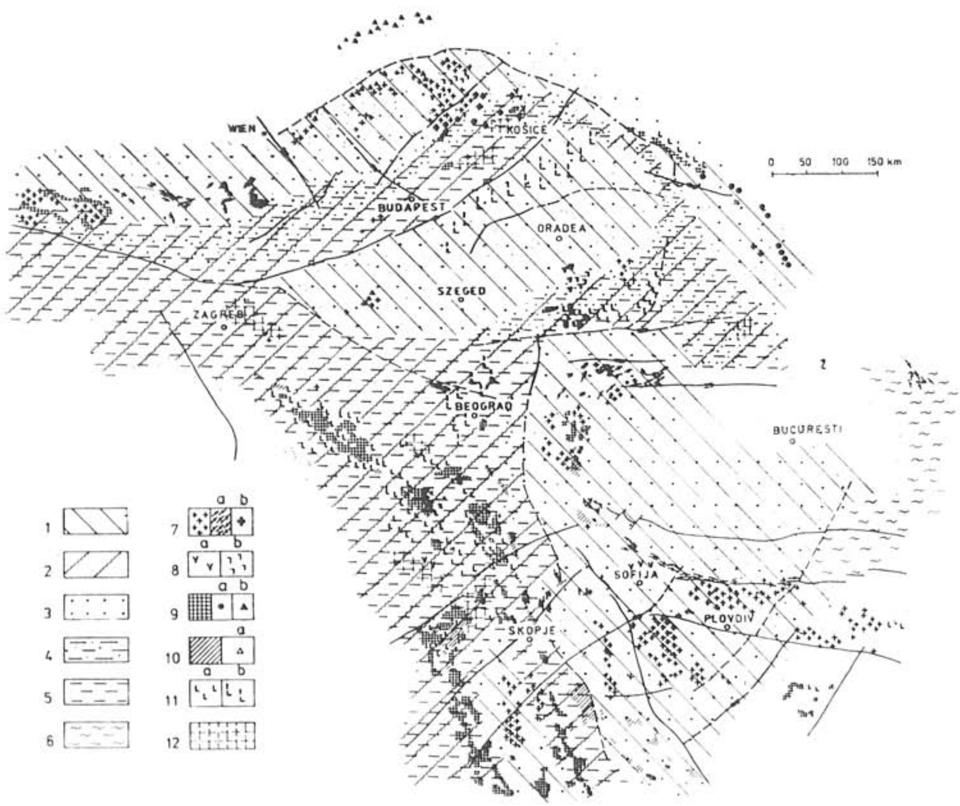

Fig. 4. Sketch showing the differences in the Hercynian consolidation in relation to the type of Triassic development an to alpine magmatites.
Regions of different Hercynian consolidation: 1 — Regions of intensive Hercynian consolidation; 2 — Regions of slighter Hercynian consolidation.
Types of Triassic development: 3 — Quasi-platform type (continental type of crust); 4 — Austro-alpine type, mobile shelf with basins; 5 — Dinaride-paraliogeosynclinal type; 6 — Tauride Flysch type (With flysch tectofacies).
Magmatites: 7 — Hercynian granitoids a) synkinematic, b) alkalic; 8 — Permian a) quartz porphyries, b) melaphyres (in nappe position); 9 Ultrabasites a) minor bodies — mostly in nappe position, b) alkalic; 10 — Gabbros (predominantly accompanied by diabases), a) alkalic diabases; 11 — Spilites-diabases, partly the hybrid association: diabase-porphyrite-quartz porphyrite, keratophyre; 12 — Triassic diabase-porphyrites, keratophyres-quartz porphyrites.

The structural-facial dissection is different in the individual segments with particularities of some paleotectonic elements and thus also troughs and distribution of basaltoids.

5. Characteristic of the Carpathians, also Alpides as one unit is the abundance--hypertrophy of flysch in the facial and geotectonic variety.

The facial and tectofacial differences between the individual flysch types in the CBGA Tectonic Map — (M. Maheľ 1974), up to 9 types, are not only

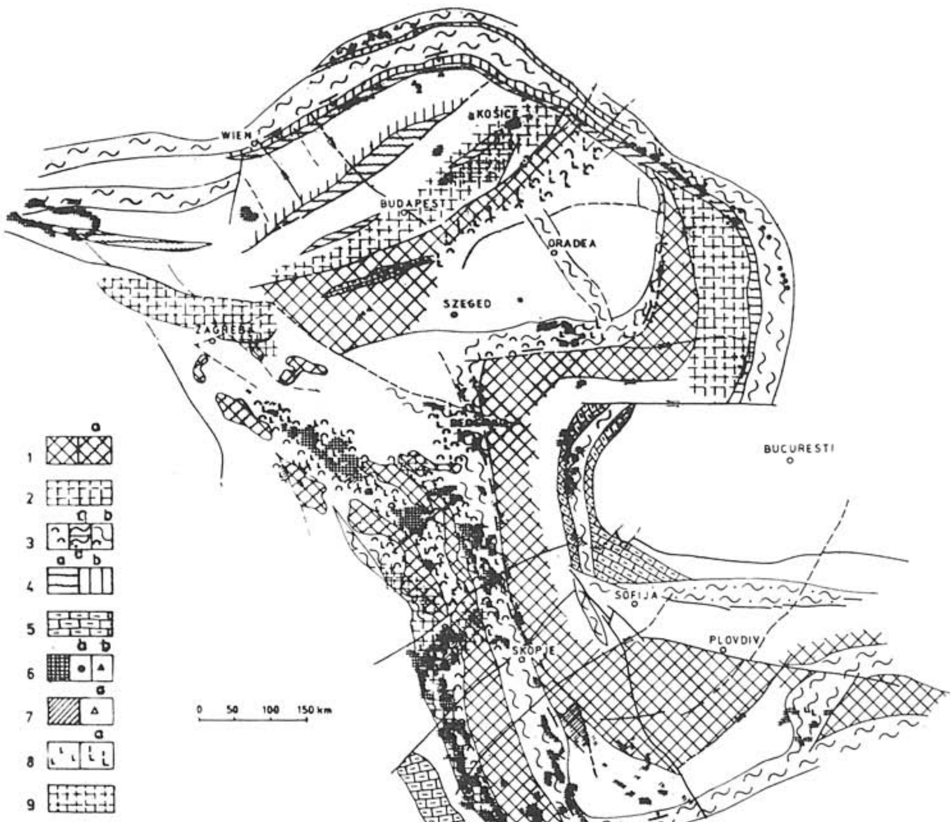

Fig. 5. Sketch-map of distribution of Upper Jurassic-Lower Cretaceous oceanic troughs in relation to ophiolites (present distribution) 1 — Central massifs a) Paleozoic exposed in the Dinarides; 2 — Areas with thin crust (quasioceanic) in the Triassic; 3 — Troughs, with oceanic crust in the Upper Jurassic and Lower Cretaceous a) with thick silicites, b) with preflysch, s) with silicites and preflysch; 4 — Troughs with thinner continental crust a) with pelagic carbonates and silicites; 5 — Basins with pelagic carbonates on plates (mostly at margins) with thicker continental crust. Ophiolites: 6 — Ultrabasites a) minor bodies, mostly in nappe position, b) alkalic; 7 — Gabbros, accompanied by diabases a) alkalic basites; 8 — Spilites-diabases and the hybrid association: diabase-porphyrite-keratophyre-quartz porphyrite a) in underlier of the Tertiary basin filling; 9 — Triassic diabases (accompanied by smaller intrusive bodies); in lower parts the hybrid association: diabase-porphyrite-keratophyre-quartz porphyry.

a consequence of variety, differences in paleotectonic position of the flysch basins but also of particularity of development of the individual regions. The flysch with layers of organogenic limestones or Adriatic type in the Dinarides is a consequence of the position of flysch basins adjacent to the limestone platform or to limestone ridges. On the contrary, the carbonate flysch of Sinaja type in the Carpathians is linked with a deep-water carbonate trough. The great variety and variability of flysch types with abundant wildflysch are characteristic of the zones of greatest facial contrastnesses of the Jurassic and Lower Cretaceous, the zone of most intense multiple shortening of the Klippen Belt.

The ophiolites but also basaltoids occur just in the Flysch of preflysch type, usually carbonate (Sinaja type) or shaly flysch (Penninicum) (Fig. 7). To transitional facies between the flysch and molasse are bound early late-geosynclinal volcanics of Priabonian-Oligocene age in the Balkans.

Of particular position and importance in the structure of the Alpides are flysch zones of wide time range with several development stages and several tectofacial flysch types, e. g. the Flysch Belt of the Eastern Alps—West Carpathians—East Carpathians, Luda Kamchyja in the Balkans, Bosniak-Durmitor Zone in the Dinarides; also the Vardar Zone. Just these zones are in close relation to the foregoing trough types with sequences accompanied by ophiolites or basaltoids.

The differences in the geotectonic position of flysch, expressed by differences in time range but also in relations to folding, are particularly distinct in the West Carpathians between the pre-tectonic flysch (e. g. the Albian-Cenomanian of the Krížna nappe and Tatride units) and late-tectonic flysch (Central Carpathian). The facial and tectonic variety of flysch is an evidence of multivariousness of development of the Alpine system with many particularities in each segment.

To such particularities in the Balkans belong the Upper Cretaceous volcanic flysch of the Strednogorje linked with banatite association.

6. The Alpine folding as the main builder of the structure of the Alpides displays some features common in the whole Alpides. They are mainly (M. Maheľ 1973, 1974) — periodicity with four periods: Kimmerian, mainly Paleoalpine, Meso-and Neoalpine, — abundance of nappes and lesser portion of granitoids, — differences in the intensity and manifestation of the individual folding periods in the orogenetic polarity and in the shortening intensity of the individual zones.

The Carpathians are a classical example of intense shortening of all zones. Also such zones which throughout all their development were ridges with thicker crust underwent shortening. Shortening affected not only sequences of the Alpine cycle but also the older crystalline basement. The intensity of shortening and thus also the tectonic style of the crystalline basement are, however, different in each zone. Distinct deep tectonic lines as are the Lednica, Peripieninic, Čertovica, Muráň, Lubeník, Rožňava, Darnó and Balaton lines in the West Carpathians, are boundaries of zones of different shortening intensity, boundaries of zones of different tectonic styles. In each of them, however, it is necessary to consider to what a degree underthrusting or also downsucking of the original basement of the sedimentation areas of the structural-facial zones of the Alpine geosyncline could have taken place. Several of the above mentioned lines are without doubt deeply anchored in the crust. Their surficial manifestation is usually younger, e. g. the Muráň fault line is probably the outer border of rooting of nappe overthrusts of the complex of units, ranged as the Kráľová hoľa Zone.

And just because shortening is taking place in each geotectonic zone, each structural-facial zone, tectonic units are forming from ridges as well as troughs, however, being of different tectonic style.

I cannot agree with the views of shortening of the sedimentation areas and formation of tectonic units mainly put into connection with ophiolite zones. The less one may agree with the opinion that the Inner Carpathians equally as the Northern Calcareous Alps represented more or less passive blocks. We know that there is not only detachment and overthrusting of the upper complexes but a process accompanied by deep processes as diaphthoresis and partly also granitization, particularly distinct in the northern trough part of the Veporides, also in the southern ridge part of the Veporides.

The complementary couples, mutually linked in structure and facies: trough--ride, trench-cordillera are also linked tectonically, form units-zones of higher order. As examples I mention: the Krížna nappe with the partial sections of Zliechov trough type and Vysoká ridge type; the Klippen Belt with the Kysuca--Pieninic trough unit and Czorsztyn cordillera unit; the tectonic zone of the South Slovakian Karst with the Meliata trough and Silica ridge units; the Magura nappe of trough-trench type with its appendage — the slope of cordillera with the Premagura unit. In each of these couples the different material content, different type of tectonogroups is shown in differences in the tectonic style (klippen style in case of the Czorsztyn unit, partly also Vysoká unit), style of recumbent folds in through units (Zliechov and Kysuca-Pieninic); nappe plates (of the Magura unit) and the pillow-like character of the aleuritic flysch of the Premagura unit. Concerned is, however, a structural dissection of lower order; indicating further stressing of structural dissection.

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Fig. 6. Model of geotectonic evolution of the West Carpathians.
1 — Upper Mantle; 2 — Granite-gneiss layer; 3 — Overthrust units; 4 — Occurrences of high-temperature and high-pressure metamorphism; 5 Subduction zones; occurrences of high-pressure and low-temperature metamorphism; 6 — Granitoid penetrations: a) diapiric ascendances; 7 — Volcanic occurrences: a) predominantly with quartz--porphyries; b) predominantly with spilite-diabases; melaphyres; 8 — Ophiolites and „ophiolitoid" magmatites; 9 — Thick radiolarites; 10 — Facies of troughs, predominantly marls; 11 — a) Fliysch and b) coarse flysch" 12 — a) Shelf detrital sediments with predominantly pelites b) sandstones; 13 — a) Shelf and swell carbonates b) of intrageosynclinal ridges, c) pelagic carbonates of basins; 14 — Molasses; 15 — Ascendances of basic and ultrabasic magma; 16 — Overthrust lines; deep faults; 17 — Zones of crust dilatation.
Deep faults: B — Balaton line; D — Darnó line; 4 — Rožňava line; L — Lubeník line; Muráň line; Čertovica line; Pp — Peripieninic line; Le — Lednica line.

Main tectonic units, their sedimentation areas: B — Bükkide; S — Szendrö-Silicicum; ME — Meliata unit; G — Gemericum; Ch — Choč units; SV — South Veporicum; NV — North Veporicum — Krížna unit; T — Tatricum; KB — Klippen Belt; M — Magura unit; Si — Silesian unit.


P
T
J–Cr 1
Cr 2
Cr 3
Pg 1–2
Pg–Ol/N
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The analysis of tectonic styles in the West Carpathians shows also the differences in the quality of folding processes in the individual zones. Another type of folding processes affected the Tatrides, another one the Veporides. These differences are also conspicuous in zones, which often are considered as subduction zones. In the Klippen Belt is shortening but without more distinct manifestations of high-pressure metamorphism. On the contrary, in the ophiolite zone south of the Rožňava fault line, in the Meliata group, shortening is lesser

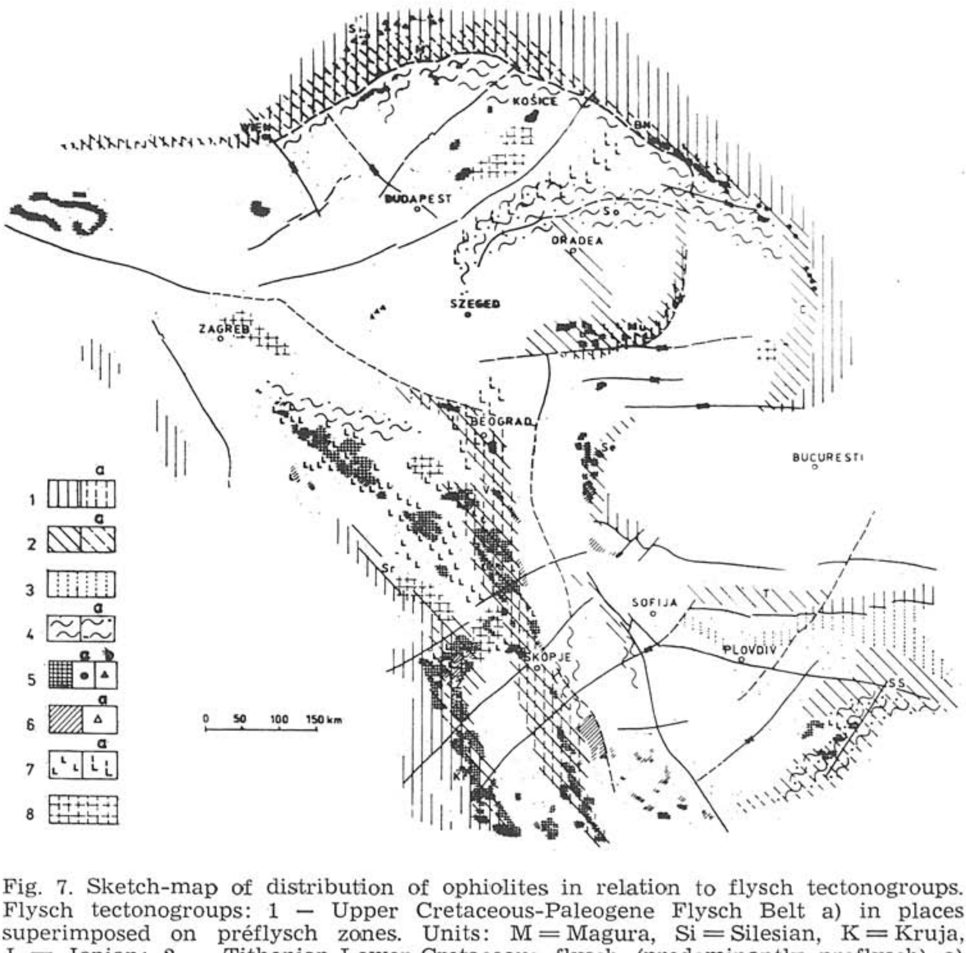

Fig. 7. Sketch-map of distribution of ophiolites in relation to flysch tectonogroups. Flysch tectonogroups: 1 — Upper Cretaceous-Paleogene Flysch Belt a) in places superimposed on préflysch zones. Units: M = Magura, Si = Silesian, K = Kruja, J = Ionian; 2 — Tithonian-Lower-Cretaceous flysch (predominantly preflysch) a) underlying the later flysch: So = Szolnok, Bn = „Black Flysch", C = Ceahlau, Se = Severin, T = Trojan, SS = Strandža, Sr = Sarajevo, V = Vardar Zone, Mu = Mureš, Z = Zukali (Gassi); 3 — Upper Cretaceous volcanogenic flysch with relations to banatites; 4 Flysch to flyschoid of back-arc type a) in the underlier of the molasse filling; 5 — Ultrabasites a) small bodies, mostly in nappe position, b) alkalic; 6 — Gabbros (accompanied by diabases), a) alkalic; 7 — Spilites-diabases and the hybrid association: diabase-porphyrite-keratophyre-quartz porphyry, a) in the underlier of the Tertiary basin filling; 8 — Triassic diabases accompanied by smaller intrusives; in lower parts the hybrid association: diabase-porphyrite-keratophyre-quartz porphyry.

and manifestations of low-thermal and high-pressure metamorphism with glaucophanites are distinct, however, also here one may speak about a trend towards the klippen style. Obviously not only the intensity but also the quality of folding was different in the individual Alpide zones.

The Klippen Belt of the Carpathians is still instructive in one point. It was shortened most intensely, in places even hundred times and there are no distinct angular discordances. The paleogeographical and structural analyses, however, unambigously show intense Paleoalpine and Mesoalpine and lesser Neoalpine shortening (according to K. Birkenmajer (1965) Paleoalpine shortening was 40 %, Mesoalpine 40 % and Neoalpine 20 %). The wildflysch conglomerates with exotic material from the Albian to the Eocene point not only to one of several-periods but probably also long-dated more or less continuous process of shortening, characteristic of subduction zones.

It is just the new global tectonics that stimulates to distinguish several types of shortening, folding, different in the individual zones not only in intensity, quality but also in time distribution, also in the Carpathians.

All the mentioned differences in folding manifestations in the intensity, quality and time distribution contributed to formation of tectonic units and so to stress structural zonality and dissection, which is an organic culmination of the structural-facial dissection of the geosyncline. Such a conclusion contradicts the model of Stille (H. Stille 1954), rehabilitated in the last years (D. Radulescu – M. Sandulescu 1974, P. Grecula – Z. Roth 1976) with two downsucking zones: Paleoalpine for the Inner Carpathians and Neoalpine for the Outer Carpathians.

To consider the Čertovica, Muráň, Lubeník-Margecany and Rožňava fault lines and at last also the Darnó and Balaton fault lines only as surficial branches of a homogeneous subduction zone is, also with all respect to the contributions of global tectonics, too courageous. The earlier idea of a uniform sedimentation zone of the Subtatric nappes, from which H. Stille (1954) inferred his model, changed essentially. At present it is admitted in general that the mentioned tectonic lines represent boundaries of at least four geotectonic zones, different in the type of tectofacies complexes, thus of zones originated under different geotectonic conditions. It is difficult to agree also with shortening of the Flysch Belt only along the Peripieninic subduction zone. At this zone shortening of the Klippen Belt took place, mainly during the Paleoalpine and Mesoalpine periods, however, the Flysch Belt mainly during the Neoalpine period. Linking of adjacent areas between the Klippen Belt and Magura unit is though distinct also in folding manifestations – mainly in affecting of the lower members of the Magura nappe by the Paleoalpine folding and vice versa, of the Klippen Belt by the Savian folding – principal for the inner zones of the Flysch Belt. Nevertheless, in their tectofacial and structural character and thus also in development the Klippen Belt and Magura unit are so different that it appears violent to put the origin of their structure into connection with one subduction zone – Peripieninic. In shortening of the Magura and Silesian units obviously the Lednica fault zone played an important role.

7. The abundance, several-type character but also unequal distribution in the individual segments of Alpides are particularly conspicuous in the so called "subsequent" volcanics.

a) In their geotectonic character Upper Cretaceous volcanics, so called banatites, are essentially different from Tertiary volcanics. Banatites are linked with longitudinal grabens or graben-synclinorii. Their effusions took place after the molasse stage. They are affected by folding, therefore the designation interorogenic volcanics is appropriate. A higher dynamics of crust in the time of their origin is pointed out by the wide scale of differentation (rhyolites-dacites-andesites; trachytes-alkalic basalts) and the volcanoplutonic character of formations with share of large subvolcanic and hypoabyssal bodies (picrites-gabbrodiorite-granite; monzonite-gabbrosyenite-granosyenite; diorite porphyrites-granite porphyrites). As visible, besides alkalic-calc rocks a considerable portion is also taken up by alkalic rocks, mainly in later stages of magmatic activity. The more or less parallel course of the banatite zone with Paleoalpine structures leads to the opinion of their genetic relation to subduction of the Vardar ophiolite zone (B. Boccaletti et al. 1973). The Rhodope and Serbo-Macedonian massifs, in such a conception, formed an island arc and the Stred-nogorje-Timok Zone a marine basin with distinct volcanic activity of back-arc type (K. J. Hsü et al. 1977). The banatite zone, however, in the northern part of the South Carpathians and mainly in the Apuseni is running diagonally to the Paleoalpine structures and diagonally also to the course of ophiolite zones, which, moreover, are situated not to the south or west as in case of the Vardar Zone but to the east of ophiolitic Mures Zone. And this obviously makes direct genetic relation of the banatite arc to the ophiolite zones doubtful (Fig. 8). Incontestable, however, remains linking of banatites with a system of deep-seated faults, to which also formation of the Upper Cretaceous grabens and graben-synclinorii is bound. Particularly it should be stressed that banatites occur only in those segments of the Alpides, which do not display more distinct polarity of folding and the accompanying graben-synclinorii are superimposed on Paleoalpine structures.

b) Tertiary volcanics are linked with longitudinal and transversal late-geosynclinal depressions. They are also not affected by folding, therefore the term late-geosynclinal volcanics is most appropriate for them. They are distinctly manifested in the molasse filling of basins, in their gradual isolation, in stabilization and geomorphology.

Late-geosynclinal volcanics are ordered in the time dimension into two stages: 1. Eocene-Oligocene and 2. Badenian-Pliocene. Both groups are bound to depressions, thinning out of crust and desintegration. Their spatial distribution is, however, different (Fig. 9).

The Eocene-Oligocene volcanics are characteric of the inner intrageosynclinal massifs, Rhodope and Hungarian. As to time, they correspond to the beginning of the late-geosynclinal stage in the geosynclinal system and to rejuvenation or tectonic activation of the massifs. Appropriate is thus for them the term early late-geosynclinal.

The Miocene-Pliocene volcanics or neovolcanics are mainly bound to intramontane depressions in the inner zones of geosynclinal systems: they correspond to the advanced late-geosynclinal stage. Both types are linking spatially in contact areas of the intrageosynclinal massifs with inner zones of the geosynclinal system, e. g. in the Mátra Mts. in Hungary. In time succ ssion both types of the late-geosynclinal volcanics are linked by Lower Miocene rhyolites, predominantly of ignimbrite type, mainly extending in the Hungarian massif.

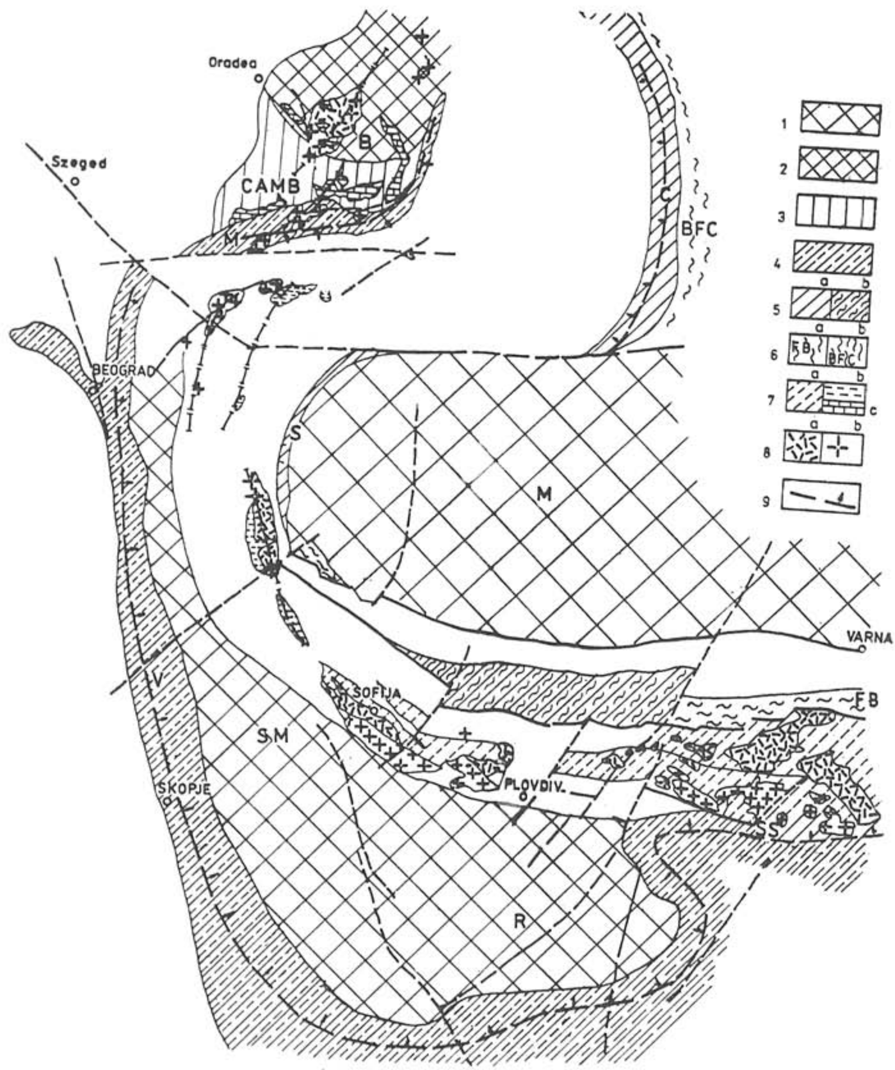

Fig. 8. Sketch showing the geotectonic position of banatites. 1 – Platforms (M = Moesian) and central massifs (SM = Serbo-Macedonian; R = Rhodope); 2 – Bihor autochthon; 3 – Nappe units of Northern Apuseni Mts.-CANB; 4 – Zones with ophiolites: M = Metalliferous; V = Vardar; 5 – a) Zones of preflysch with accompaniment of basites and ultrabasites: C = Ceahlau; S = Severin; SS = Strandja, b) Trojan Flysch zone (Tithonian-Lower Cretaceous; 6 – a) Flysch Zone of the Balkanides = FB, b) BFC = the main flysch zone of the East Carpathians; 7 – Upper Cretaceous complexes accompanying banatites a) flysch, b) various volcanic-sedimentary facies, c) Gosau type, little affected by folding; 8 – Banatites a) major effusive bodies, b) subvolcanic and plutonic bodies; 9 – Subduction zones.

In the Carpathian literature already since the time of H. Stille (1953), mainly, however, in the last periods (E. Szádecky-Kardoss (1968, J. Slávik 1974, D. Radulescu – M. Sandulescu 1973, P. Grecula – Z. Roth 1976) more often we find the opinion of direct genetic relation of neovolcanics to subduction of the Carpathian Flysch Belt. Such an explanation, however, impairs the lack of neovolcanics in the Eastern Alps (with the exception of insignificant occurrences) although the Flysch Belt continues from the Carpathians to the west directly into the Alps. A relatively small portion of

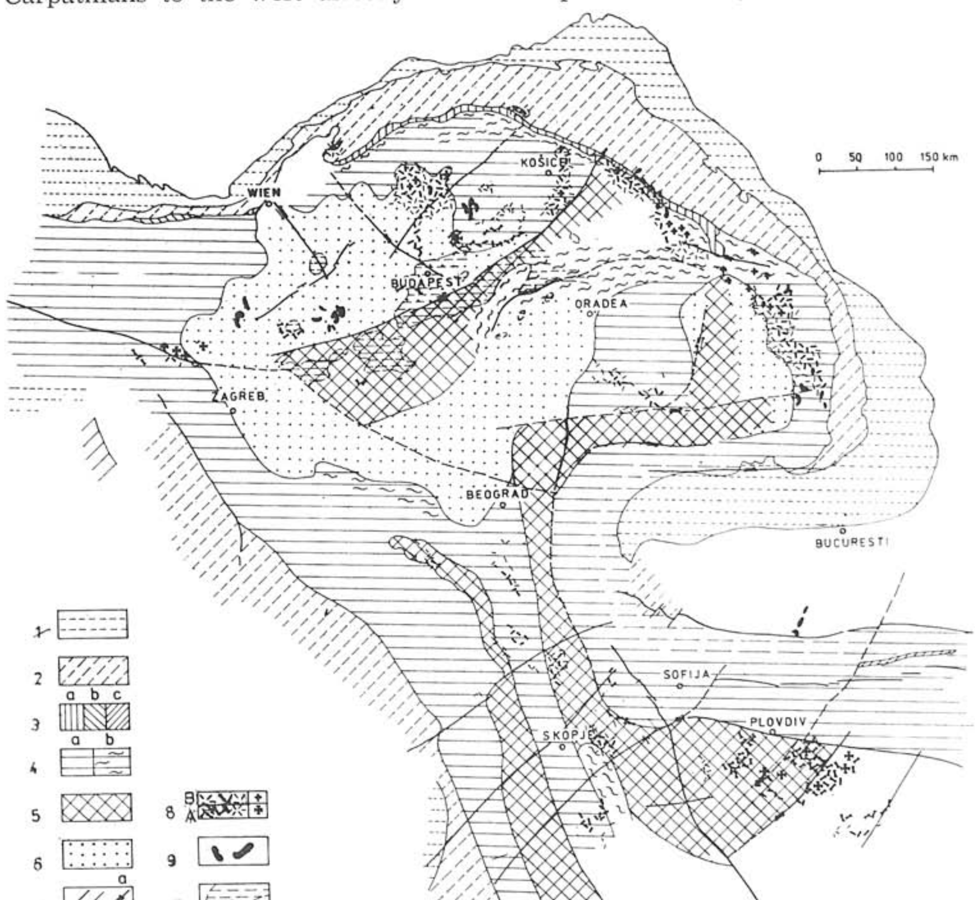

Fig. 9: Geotectonic position of late-geosynclinal volcanics. 1 – Foredeep; 2 – Flysch Belt of the Carpathians, Eastern Alps and outer zones of the Dinarides-Hellenides and Balkans; 3 – a) Klippen Belt, b) Gresten Zone, c) Kotel Zone; 4 – Inner zones a) Late-tectonic (back arc) flysch; 5 – Intrageosynclinal massifs; 6 – Inner depressions; 7 – Principal tectonic lines a) strike-slip faults; 8 – A) Early late-geosynclinal volcanics (Upper Eocene-Oligocene), a) pyroclastics, b) hypoabyssal and intrusive bodies, 8 – B) Late-geosynclinal volcanics (Miocene-Pliocene) a) pyroclastics, b) hypoabyssal and instrusive bodies; 9 – Basalts (Pliocene-Quaternary); 10 – Major subsurface bodies of Lower Miocene volcanics.

volcanics is in the Dinarides and they are lacking in the South Carpathians. On the contrary, thick complexes are in the Hungarian massif, Rhodope massif, at the margin of the Transylvanian massif, smaller occurrences also at the western margin of the Serbo-Macedonian massif. Obviously these massifs, situated at the boundary of Alpine branches of different vergency, played an important role in manifestation of late-geosynclinal volcanism and of deep processes linked with it.

We take into consideration alternation of formation of the inner depressions in the Carpathians with the origin of nappe units with manifestations of crust shortening in the Flysch Belt (M. Mahel 1974) – (Fig. 9), we cannot neglect the interplay of horizontal compressional movements in the outer parts of the Carpathians with vertical movements, desintegration and thinning of the continental crust in the hinterland and inner parts. The intrageosynclinal massifs appear to us as a further, very important factor, which influences distribution of neovolcanics besides those factors as underthrusting or subduction of crust and origin of the depression. In Alpine segments without stabilized blocks in the rear part more distinct vertical movements leading to formation of depressions with accompanying late-geosynclinal volcanics were not evident. In these blocks obviously subduction was not compensated by formation of diapir.

8. What is global and what of more restricted extent, this is a very difficult question particularly in tectonics where the depth dimension and with it many unknown factors come to the foreground. We however, can help us with manifestations, which incontestably are connected with deep processes. I have in mind the differences in representation of nevolcanics in the West Carpathians – abundant, practically insignificant in the Eastern Alps and South Carpathians. They indicate the fundamental differences in development, thus also in the model of the geosyncline. But also formation of depressions hardly can be only a surficial phenomenon when we know that usually larger depressions are linked with thinning out of continental crust. Then such differences as e. g. between the Eastern Alps (mainly with Upper Cretaceous-Paleocene depressions with filling of Gosau early molasse type), the West Carpathians (with Eocene--Lower Oligocene depressions with filling of post-tectonic flysch and with Neogene molasse depressions) and the South Carpathians (practically without more distinct depressions), hardly can be near-surface phenomena only. In paleogeographical and paleotectonic sense obviously the uniformity of the model even in the European Alpides should be considered at least as schematization for a global scale.

Structural-facial and structural dissection of the European Alpides is obviously a characteristic feature of the Alpides, distinctly contrasting with the simpler Hercynian Precarpathians. Reduction of such a dissection into two fundamental types: continental blocks and ophiolite zones – or remnants of oceans is at least such a schematization as was division into the mio-and eugeosyncline. We, however, know how difficult it was for us to press the Carpathians into such a narrow frame. I emphasize and repeat the contribution of new global tectonics as I see it; in its dynamic view of paleogeography; focusing its attention on the thickness and type of crust; enlargement of criterii in judging the folding and types of crust shortening. From these aspects also structural-facial and structural dissection of the European Alpides appears to us though genetically more variegated but more logical in several directions.

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